U.S. Department of Energy's

Office of Science

Fusion Energy Sciences Program

Plasma Science Committee

The National Academy of Sciences

Office of Fusion Energy Sciences

Excellent Science
Attractive Energy

www.ofes.fusion.doe.gov

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April 2, 2004

Topics

- Budget Update
- Goals and Milestones
- ITER
- NCSX Project
- IFE/HEDP Program
- FES FY 2004 Solicitations
- SC Strategic Plan
- 20-Year Facilities Plan
- The Moral Imperative . . .

The Office of Science FY05 Budget Request

(dollars in thousands)

	FY 2003 Comparable Approp.	FY 2004 Comparable Approp.	FY 2005 President's Request	FY 2005 Request vs. FY 2004 Appropriation	
Science					
Basic Energy Sciences……	1,001,941	1,010,591	1,063,530	+52,939	+5.2%
Advanced Scientific Computing Research……	163,185	202,292	204,340	+2,048	+1.0%
Biological & Environmental Research……	494,360	641,454	501,590	-139,864	-21.8%
Congressionally-directed projects……	*(51,927)*	*(140,762)*	*(——)*	*(-140,762)*	*(-100.0%)*
Core Biological and Environmental Research……	*(442,433)*	*(500,692)*	*(501,590)*	*(+898)*	*(+0.2%)*
High Energy Physics……	702,038	733,631	737,380	+3,749	+0.5%
Nuclear Physics……	370,655	389,623	401,040	+11,417	+2.9%
Fusion Energy Sciences……	240,695	262,555	264,110	+1,555	+0.6%
Science Laboratories Infrastructure……	45,109	54,280	29,090	-25,190	-46.4%
Science Program Direction……	137,425	152,581	155,268	+2,687	+1.8%
Workforce Development for Scientists & Teachers……	5,392	6,432	7,660	+1,228	+19.1%
Small Business Innovation Research/Technology Transfer……	100,172	——	——	——	——
Safeguards and Security……	61,272	56,730	67,710	+10,980	+19.4%
Subtotal, Science……	3,322,244	3,510,169	3,431,718	-78,451	-2.2%
Use of prior year balances……	——	-10,000	——	+10,000	+100.0%
Total, Science……	**3,322,244**	**3,500,169**	**3,431,718[a]**	**-68,451**	**-2.0%**
Total, excluding Congressionally-directed projects……	*(3,270,317)*	*(3,359,407)*	*(3,431,718)*	*(+72,311)*	*(+2.2%)*

[a] *Note, when compared to the FY 2004 request (comparable), the FY 2005 request increases $104,885,000 (3.2%).*

FY 2005 Fusion Energy Sciences President's Budget Request

	FY 2003 Actual	FY 2004 Approp.	FY 2005 Cong.
Science	136.2	143.9	144.0
Facility Operations	66.2	84.5	85.5
Technology	38.3	27.4	27.8
SBIR/STTR	6.2	6.8	6.8
OFES Total	*246.9*	*262.6*	*264.1*
DIII-D	51.9	56.0	54.0
C-Mod	19.2	22.2	21.5
NSTX	30.1	34.7	33.6
NCSX	11.7	16.7	16.7
IFE/HEDP	17.0	15.1	13.9

Summary of Fusion Energy Sciences FY 2005 Program

ITER

- o Direct Funding of $7M: $1M for procurement of S/C Wire; $6M in reserve awaiting selection of organization to host U.S. Project Office and other decisions
- o Total of $38 M in resources from throughout the program will support preparation for U.S. tasks

Science ($150.8 M, +$0.1 M)

- o +$1 M for Madison Symmetric Torus (MST)
- o Focus SciDAC on burning plasma physics
- o NCSX research in support of construction level
- o IFE science level, making transition to High Energy Density Physics program
- o All other programs funded at about FY 2004 appropriations level

Facilities Operations ($85.5M, +$1 M)

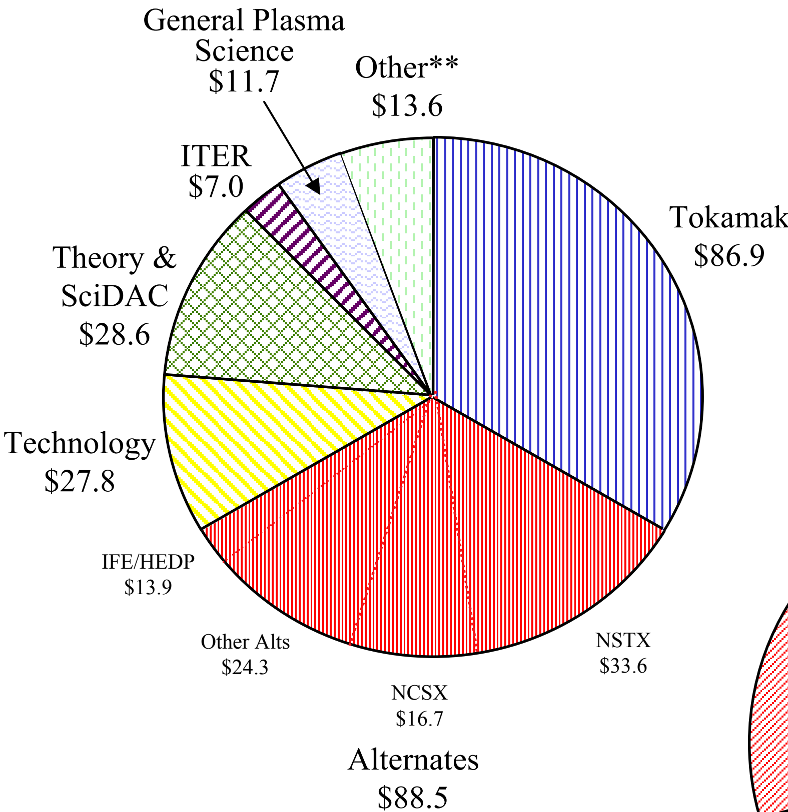
- o ITER direct funding +$4 M
- o Operation of facilities reduced from FY 2004 plan of 18 weeks each to 14 weeks each (-$3.2 M)
- o NCSX kept at FY 2004 level instead of the planned $4.8 M increase
- o Funding for ORNL move stretched out

Enabling R&D ($27.8M, $+$0.4 M)

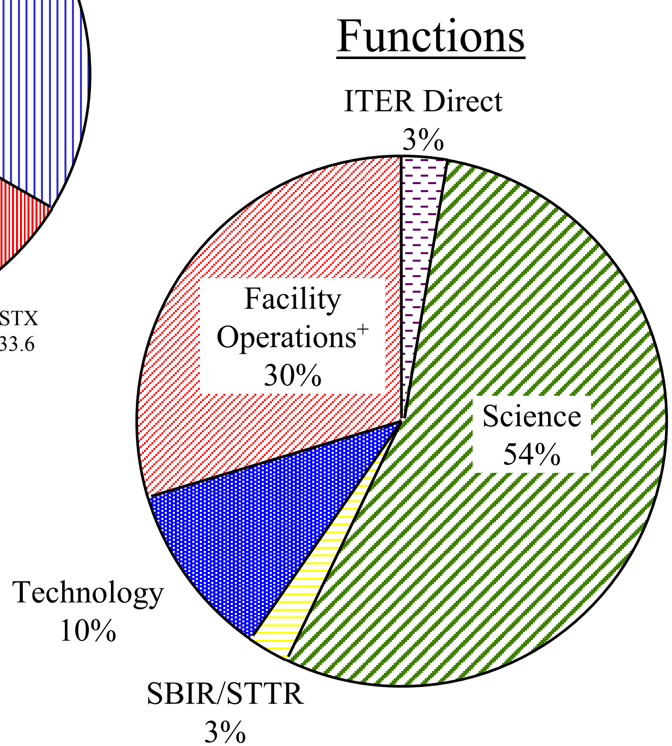
- o Fusion Technologies closed out in FY 2004, some parts moved to Plasma Technologies
- o FIRE program wrapped up with Physics Validation Review in FY 2004

Fusion Energy Sciences Funding Distribution

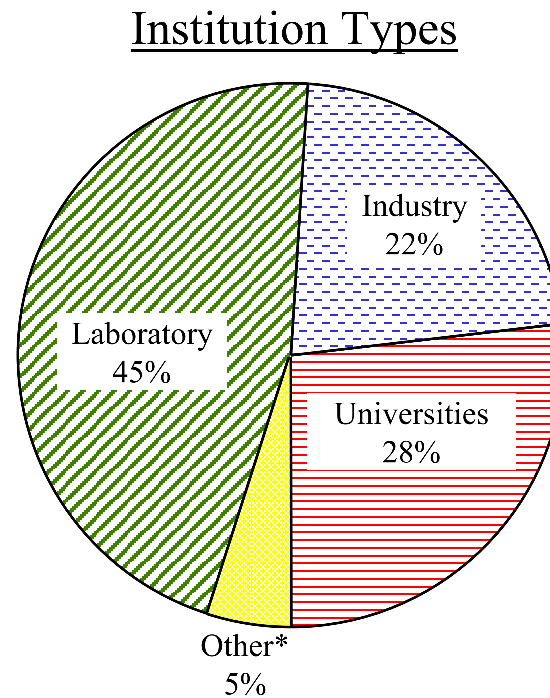
FY 2005 Congressional
$264.1M



**SBIR/STTR
GPP/GPE
ORNL Move
Reserve
Environmental Monitoring



+Includes NCSX Project



*NSF/NIST/NAS/AF/
Undesignated funds

Fusion Energy Sciences Long Term (10 year) Goals

1. Predictive Capability for Burning Plasma

   Develop a predictive capability for key aspects of burning plasmas using advances in theory and simulation benchmarked against a comprehensive experimental database of stability, transport, wave-particle interaction, and edge effects.

2. Configuration Optimization

   Demonstrate enhanced fundamental understanding of magnetic confinement and improved basis for future burning plasma experiments through research on magnetic confinement configuration optimization.

3. Inertial Fusion Energy and High Energy Density Physics

   Develop the fundamental understanding and predictability of high energy density plasmas.

FY 2004 and FY 2005 Targets

- Average achieved operational time of major national fusion facilities as a percentage of total planned operational time is greater than 90%

- Cost-weighted mean percent variance from established cost and schedule baselines for major construction, upgrade, or equipment procurement projects kept to less than 10%

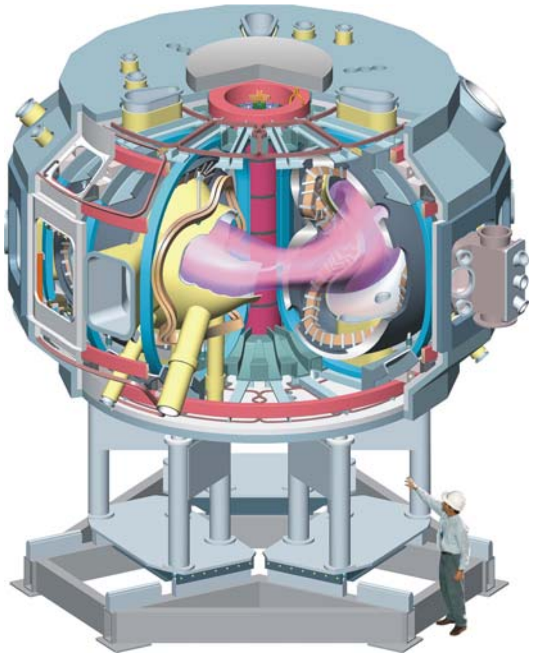
NCSX FY 2004 and FY 2005 Targets

FY 2004 Target Milestone:

Established, in February 2004, the performance baseline (i.e. cost, schedule and technical scope) of the National Compact Stellarator Experiment (NCSX). The Total Estimated Cost for NCSX is $86.3M with completion in May 2008.

FY 2005 Target Milestone:

Begin NCSX fabrication (i.e. Critical Decision 3) and award, through a competitive process, production contracts for the NCSX Modular Coil Winding Forms and Vacuum Vessel.



NCSX

Status of ITER – Remaining Issues

1. Site Selection Pending

Rokkasho, Japan

Cadarache, France, EU

Parallel Activities to Prepare the US to Act Following Site Selection

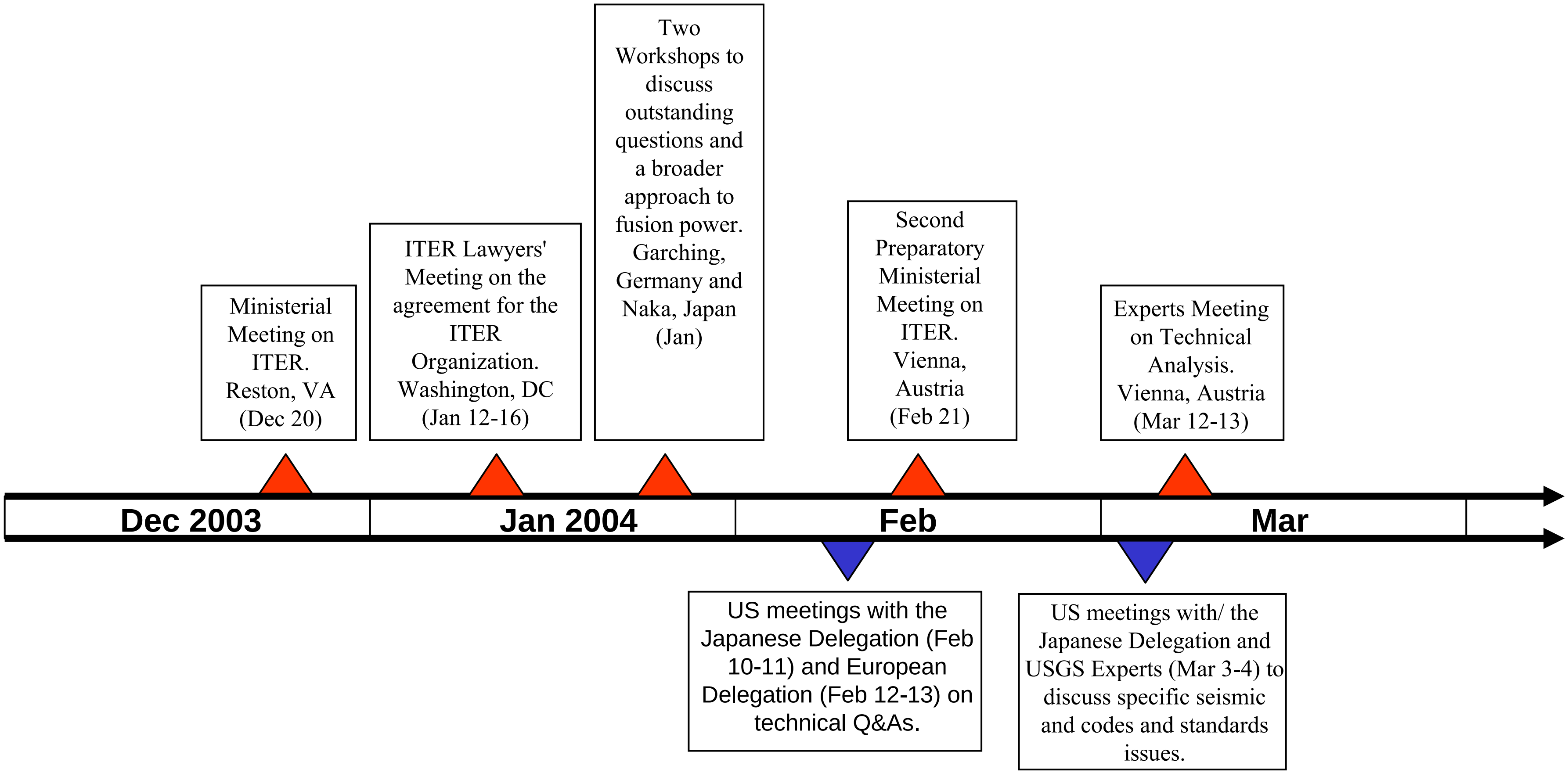
2. Agreement Text Pending – legalities and interpretations
3. Key Personnel – Secondees, US ITER Project Office, ITER Organization
4. OFES Program and Community Preparation for ITER
5. Licensing – responsibility of host site
6. Funding – executing FY 04, defending FY05, and planning FY06
7. Construction Start – 2006?

Remaining Issue #1

Status of ITER – Site Selection

Timeline of Major Activities Related to ITER Host Sites Negotiations

(Rokkasho, Japan and Cadarache, France, EU)



▲ Denotes meetings where all six ITER parties were present.

▼ Denotes meetings where the US met with another ITER party.

Fusion Program Resources in Preparation for ITER

Elements	FY 2004 Approp.	FY 2005 Cong.
Fusion Plasma Theory and Computation (SciDAC)	$1,000,000	$3,000,000
DIII-D Experimental Program	3,000,000	10,000,000
Alcator C-Mod Experimental Program	1,000,000	5,000,000
ITER Preparations	3,000,000	7,000,000
Plasma Technology	0	13,000,000
Total	*$8,000,000*	*$38,000,000*

NCSX Project

- Evolution of design and response to design reviews raised project cost to $83M
- New definition of project completion and new funding profile result in cost and schedule impact
- Total project cost is now $86.3 million, completion in FY 2008

	FY 2003	FY 2004	FY 2005	FY 2006	FY 2007	FY 2008
New Profile	7,897	15,921	15,921	22,100	19,400	5,100
Previous Profile	7,897	15,921	20,397	17,800	11,485	

($69 M – 83 M; completion FY 2007)

Evolution of IFE/HEDP Program

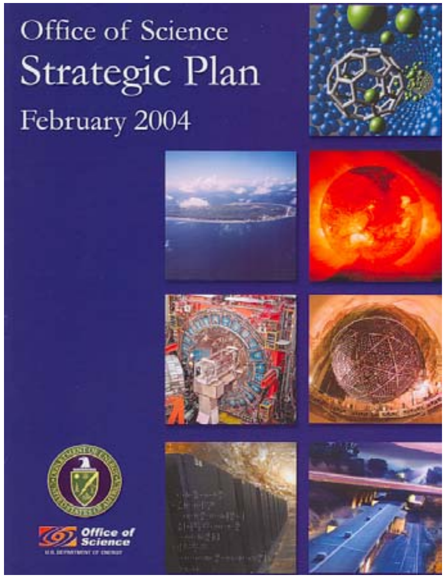
Office	**Current Program**	**Future Program**
SC	o Heavy Ion Accelerator Physics o Target Physics (modeling) o Fast Ignition o Chamber, Target Fabrication, System Studies	o Focus on science issues o Close out technology research o Develop High Energy Density Physics roadmap with DP, NSF
DP	o High Average Power Laser Program o Z for IFE	

Fusion Energy Sciences Program
FY 2004 Solicitations

Program	Decisions Complete
Fusion Science Centers	April
Junior Faculty Development	May
SciDAC	June
Theory Program	August
Innovative Confinement Concepts	August
ITER Project Office	TBD

Office of Science Strategic Plan

- Published February 2004; electronic version available at www.sc.doe.gov/



- Fusion "Broad Goals"
  - Demonstrate with burning plasma fusion's scientific/technological feasibility
  - Develop fundamental understanding for predictive capabilities
  - Determine most promising approaches and configurations for energy
  - Develop new materials, components and technologies for energy
- Success Indicators (www.science.doe.gov/measures)
  - Progress in developing benchmarked predictive capability for burning plasma
  - Progress in demonstrating enhanced understanding of magnetic confinement and in improving basis for designing future burning plasma experiments through research on confinement configuration optimization
  - Progress in developing predictability of high-energy density physics including energy applications
- "Facilities for the Future of Science: A Twenty-Year Outlook" is a companion document identifying ITER as the first priority facility for the Office of Science

Office of Science

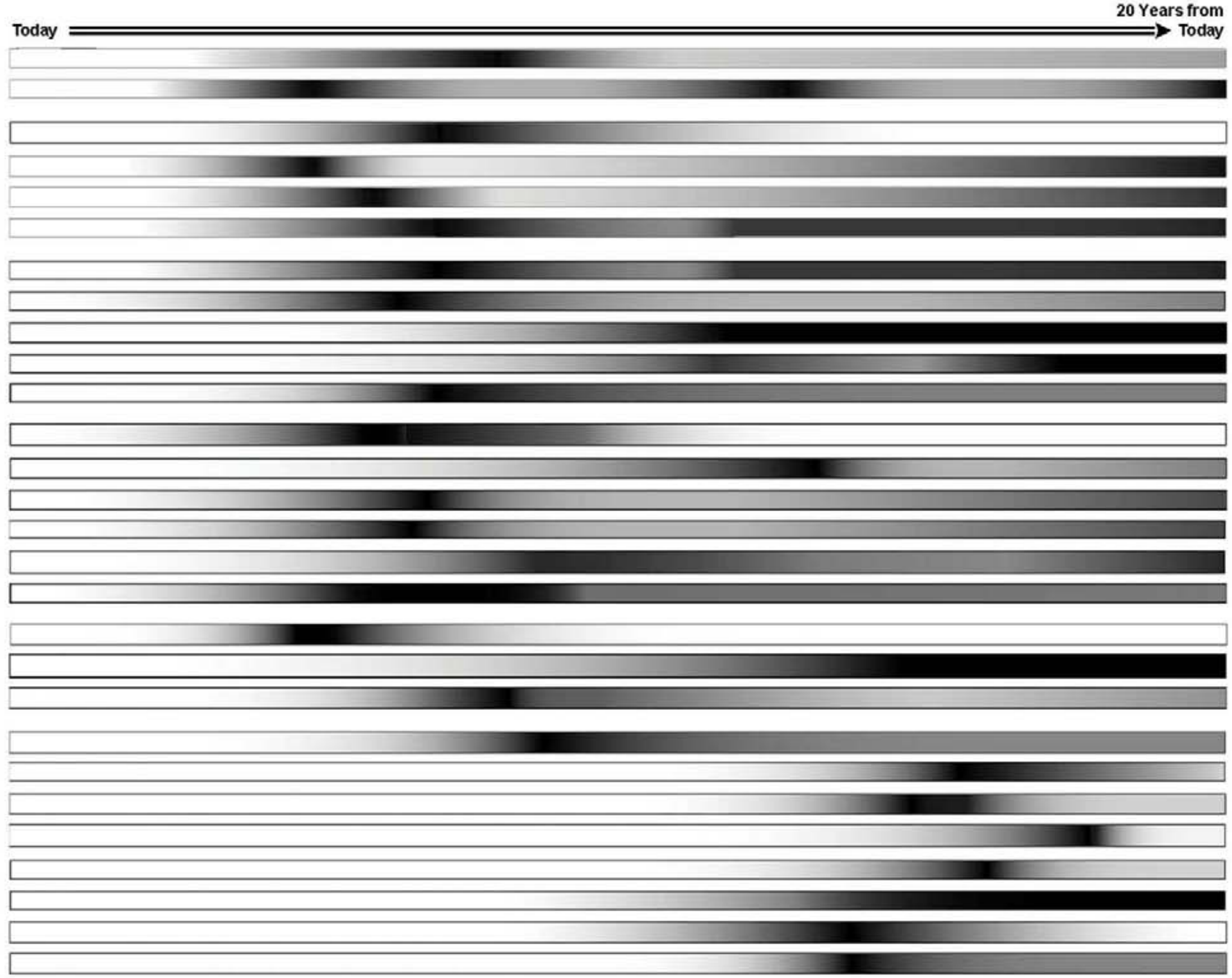
20 Year Facilities Plan

"These Department of Energy facilities are used by more than 18,000 researchers from universities, other government agencies, private industry and foreign nations."

- Secretary of Energy
Spencer Abraham

U.S. Department of Energy Office of Science 20-Year Facility Outlook Peak of Cost Profile

Term	Priority	Program	Facility
Near-Term	1	FES	ITER
Near-Term	2	ASCR	UltraScale Scientific Computing Capability
Near-Term	Tie for 3	HEP	Joint Dark Energy Mission
Near-Term	Tie for 3	BES	Linac Coherent Light Source
Near-Term	Tie for 3	BER	Protein Production and Tags
Near-Term	Tie for 3	NP	Rare Isotope Accelerator
Near-Term	Tie for 7	BER	Characterization and Imaging
Near-Term	Tie for 7	NP	CEBAF Upgrade
Near-Term	Tie for 7	ASCR	Esnet Upgrade
Near-Term	Tie for 7	ASCR	NERSC Upgrade
Near-Term	Tie for 7	BES	Transmission Electron Achromatic Microscope
Near-Term	12	HEP	BTeV
Mid-Term	13	HEP	Linear Collider
Mid-Term	Tie for 14	BER	Analysis and Modeling of Cellular Systems
Mid-Term	Tie for 14	BES	SNS 2-4 MW Upgrade
Mid-Term	Tie for 14	BES	SNS Second Target Station
Mid-Term	Tie for 14	BER	Whole Proteome Analysis
Mid-Term	Tie for 18	NP	Double Beta Decay Underground Detector
Mid-Term	Tie for 18	FES	Next Step Spherical Tokamak
Mid-Term	Tie for 18	NP	RHIC II
Far-Term	Tie for 21	BES	National Synchrotron Light Source Upgrade
Far-Term	Tie for 21	HEP	Super Neutrino Beam
Far-Term	Tie for 23	BES	Advanced Light Source Upgrade
Far-Term	Tie for 23	BES	Advanced Photon Source Upgrade
Far-Term	Tie for 23	NP	eRHIC
Far-Term	Tie for 23	FES	Fusion Energy Contingency
Far-Term	Tie for 23	BES	HFIR Second Cold Source and Guide Hall
Far-Term	Tie for 23	FES	Integrated Beam Experiment



Peak Cost ■ Near-term ■ Mid-term ■ Far-term ■

Programs:

ASCR = Advanced Scientific Computing Research
BES = Basic Energy Sciences
BER = Biological and Environmental Research
FES = Fusion Energy Sciences
HEP = High Energy Physics
NP = Nuclear Physics

Excerpts from Secretary of Energy Spencer Abraham's Speech to the National Press Club

November 10, 2003

"The prospect of a limitless source of clean energy for the world leads with our commitment to join the international fusion energy experiment known as ITER.

This is a Presidential priority with enormous potential. Successful negotiations among the international partners will lead to the first-ever fusion science experiment capable of producing a self-sustaining fusion reaction.

If we reach agreement, ITER will be our top facility."

From the

Office of Science

20 Year Facilities Plan

Facility Summaries

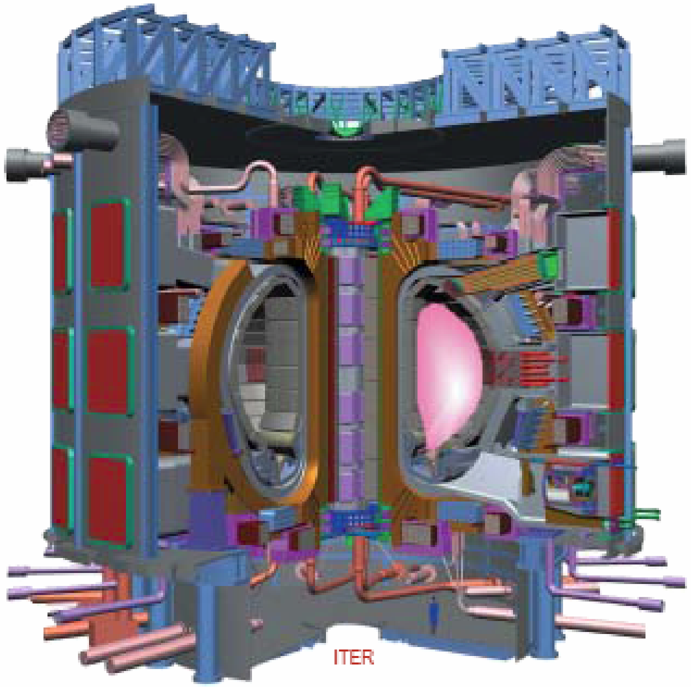
Near-Term Priorities

Priority: 1
ITER

The Facility: ITER is an international collaboration to build the first fusion science experiment capable of producing a self-sustaining fusion reaction, called a "burning plasma." It is the next essential and critical step on the path toward demonstrating the scientific and technological feasibility of fusion energy.

Background: Fusion is the power source of the sun and the stars. It occurs when the lightest atom, hydrogen, is heated to very high temperatures forming a special gas called "plasma." In this plasma, hydrogen atoms combine, or "fuse," to form a heavier atom, helium. In the process of fusing, some matter is converted directly into large amounts of energy. The ability to contain this reaction, and harness the energy from it, are among the important goals of fusion research.

What's New: Recent advances in computer modeling and in our understanding of the physics of fusion give us confidence that we can now build ITER successfully. The unique features of the facility will be its ability to operate for long durations (hundreds of seconds and possibly several thousands) and at power levels (around 500 MW) sufficient to demonstrate the physics of the burning plasma in a power-plant-like environment. ITER will also serve as a test-bed for additional fusion power-plant technologies.


ITER

Applications: ITER is the next big step toward making fusion energy a reality. Fusion energy is particularly attractive as a future energy source because it is environmentally benign (it produces no air pollution and no carbon dioxide, and it does not create long-lived radioactive waste); its fuels are easily extracted from ordinary water and from lithium, an abundant element; and it can be generated on demand and in sufficient capacity to power large cities and industries.

Fusion Energy – The Moral Imperative

- Current world energy usage is not environmentally sustainable
- The potential role of fusion in alleviating poverty is a powerful social good which needs to be explored
- Our legacy for future generations is **clean**, **safe** energy
- All scenarios indicate that energy sustainability is attainable only by a **mix** of policies, plans, technologies, and funding
- Fusion energy is not the **only** solution but should be **part** of the solution